STATUS OF MINERAL RESOURCE INFORMATION FOR THE YAVAPAI INDIAN RESERVATION YAVAPAI COUNTY, ARIZONA

by

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Prepared by
U.S. Geological Survey and U.S. Bureau of Mines
for
U.S. Bureau of Indian Affairs

Administrative Report BIA-64
1980

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SUMMARY AND CONCLUSIONS

The Yavapai Indian Reservation is in a mineralized region. In the past, the region has produced significant quantities of copper, gold, lead, silver, and zinc, and minor amounts of barite, building stone, mercury, and tungsten. Fluorite and olivine have been identified but have not been found in quantities sufficient to warrant investigation.

In recent times, the reservation has produced about 245,000 cubic yards of sand and gravel, an estimated 500,000 cubic yards of decomposed granite fill, and a small amount of placer gold.

From 1863 until 1965, the present Yavapai Indian Reservation was part of a Military Reservation known as Fort Whipple. Because of this status, the reservation probably has not been prospected thoroughly, and the mineral potential, if any, is unknown.

INTRODUCTION

This report was prepared for the Bureau of Indian Affairs (BIA) by U.S. Geological Survey (USGS) and the Bureau of Mines (USBM) under an agreement to compile and summarize available information on the geology, mineral resources, and potential for economic development of certain Indian lands. Source material included published and unpublished reports and personal communications. No fieldwork was done.

The Yavapai Indian Reservation is immediately adjacent to and northeast of the city of Prescott, Yavapai County, Ariz. (Figure 1). The reservation surrounds the Whipple Veterans Administration Reservation on three sides; the two reservations and a city park form a diamond-shaped parcel of land with the long axis bearing northwest about 3.5 miles and the short axis bearing northeast about 1.5 miles. The area occupied by the Yavapai Indian Reservation totals 1,409 acres (Bureau of Indian Affairs, 1978).

The reservation is hilly, bisected along its short axis by the intermittent, northeast flowing Granite Creek, which is the principal stream draining the Prescott area. A number of ephemeral streams that flow into Granite Creek and its tributaries, Slaughterhouse Gulch and Government Gulch, drain the reservation.

Relief is about 620 feet between a hill in the southeast sector at about 5,880 feet elevation and the bed of Granite Creek where it flows out of the reservation near the northeast corner at an elevation of about 5,260 feet.

Transportation facilities are good. State Highway 69 crosses east-west through the southern part of the reservation, and U.S. Highway 89 passes north-south through the central part of the reservation. A branch line of the Atchison, Topeka & Santa Fe Railway runs northwest through the central part of the reservation. Commercial truck and bus service is available in Prescott. Commercial airlines use an airport about 6 miles north of the reservation.

Two high-voltage electrical transmission lines cross the reservation, one northeasterly in the central part and one north-south in the northwestern corner. One gas pipeline of the Southern Union Gas Co. crosses the northwest corner of the reservation.

The climate is semiarid; annual rainfall averages slightly over 19 inches. The highest recorded

annual rainfall was 35.94 inches in 1965, and the lowest was 6.88 inches in 1956. The wettest period is usually from early July through mid-September, and the driest is generally during May and June. Seldom do summer temperature rise to 100°F or winter temperatures fall to 0°F. Freezing winter nights are common, and about half the winter precipitation falls as snow (Sellers and Hill, 1974).

Present grazing on the reservation is limited to about 40 head of livestock. A creosote-pine-pole factory is in operation and a site is being developed for a small commercial park. Plans are also being considered for suburban and commercial development on parts of the reservation.

PREVIOUS INVESTIGATIONS

Areas around the Yavapai Indian Reservation have been the subject of considerable study, partly because of the occurrence of numerous mineral deposits. No specific study of the reservation has been made, but it is within a larger area (two quadrangles) studied geologically by Kreiger (1965). No mineral deposits on the reservation are mentioned in the report, but geologic map (plate 1 of the report) shows veins, dikes, a fault, a large shear zone, and gravel deposits.

Principal mines of the region were the United Verde, the United Verde Extension, and the Iron King Mine; all have been inactive for years. These by properties are described Creasey (1952), Anderson and Creasey (1958, Kreiger (1965), Gilmour and Still, (1968), Wilson and others (1934) and Lindgren (1926). Lesser deposits of the region are described by Eilers (1872), Blandy (1883), Jaggar and Palache (1905), Lingren (1926), Lausen and Gardner (1927), Wilson and others (1934), Wilson (1941), Wilson and Fansett (1961), Dale (1961), Kreiger (1965) and others.

MAP COVERAGE

The reservation is shown on a U.S. Geological Survey 15-minute quadrangle topographic map entitled "Prescott" and on a 7½-minute quadrangle topographic map also entitled "Prescott." These are at scales of 1:62,500 and 1:24,000, respectively. A. U.S. Army Map Series (AMS) 1:250,000-scale map, NI 12-4, Series V502, entitled "Prescott", also covers the reservation. Geology is shown on the Arizona Bureau of Mines and U.S. Geological Survey map "Geologic Map of Arizona" at a scale of 1:500,000. All of these maps are available from: Branch of Distribution, U.S. Geological Survey Federal Center, Denver, Colorado 80225.

A geologic map of Yavapai County, including the reservation, has been published (1958) at a scale of 1:375,000 by the Arizona Bureau of Mines. This is available from the Arizona Bureau of Geology and Mineral Technology, 845 North Park Avenue, Tucson, Arizona 85719.

Aerial photographs can generally be obtained from the U.S. Geological Survey, the Forest Service, and the Soil Conservation Service of the U.S. Department of Agriculture. Satellite imagery can be obtained from the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota 57198.

GEOLOGY

Krieger's professional paper (1965) includes a geologic map of the Prescott 15' quadrangle and contains the only detailed study of the geology and ore deposits in the immediate area. Anderson and Creasy (1958) presented detailed work from the Jerome mining district to the east of Prescott. In subsequent publications, Anderson and Blacet (1972) and Anderson and others (1971) revised the stratigraphic sequences outlined by the earlier authors. The geologic discussion below is taken from Kreiger (1965) except where indicated. Figure 2 shows the geology of the reservation and surrounding area.

Within the Prescott quadrangle are volcanic, sedimentary, and intrusive rocks representing the Precambrian, Paleozoic, and Cenozoic eras.

Precambrian.-- The Yavapai Series, the oldest Precambrian unit, contains the Ash Creek Group (not found in the Prescott area) and the Big Bug Group. Basalt, andesite, and rhyolite flows and tuffaceous sedimentary rocks characterize formations in the Big Bug Group. Zircon age determinations from the Big Bug Rhyolite date it at 1175+10 m.y.(Anderson and others, 1971) which makes the Yavapai Series Precambrian X in age. Overlying the Yavapai Series in areas northeast of Prescott is the fine- to coarse-grained quartzite (with minor conglomerates and small amounts of argillite) of the Mazatzal Quartzite. Although gabbros, granodiorites, granites, and alaskites intrude the older Precambrian rocks, only the Government Canyon and Prescott Granodiorites crop out near Prescott. Krieger (pers. commun.) considers them to be Precambrian Y in age. The reservation lies on the northern extension of one mass of Prescott Granodiorite and the Government Canyon granodiorite (Figure 2). The granodiorite's fresh surfaces are medium to light gray or greenish gray and weathered surfaces are varying shades of orange. In order of abundance the rock contains plagioclase, quartz, biotite, epidote, and accessories of sphene, magnetite, ilmenite (?), apatite, and zircon. Mild regional metamorphism has altered the grandiorite and the presence of quartz, quartz-tourmaline, and tourmaline veins suggest that hydrothermal fluids may have affected it in places.

Paleozoic.-- Paleozoic rocks only appear beyond 20 km north of Prescott. They are the Cambrian Tapeats Sandstone, the Devonian Martin Limestone, the Mississippian Redwall Limestone, the Pennsylvanian Supai Formation, and the Permian Coconino Sandstone which are also found in the Grand Canyon region.

Tertiary.--Although many different sedimentary and volcanic rocks formed during the Tertiary, only basalts and sedimentary rocks occur near Prescott. Glassford Hill northeast of Prescott is a basalt cone; other basalts crop out southwest and southeast of the reservation. Sheets 3 to 6 m thick containing ropy lava and bombs characterize the basalt flows. A groundmass of felty plagioclase crystals in a mafic base of augite, olivine, magnetite, and apatite surround olivine, magnetite, augite, and plagioclase phenocrysts that average 1 mm in length. Tertiary sedimentary rocks, which are more abundant than the volcanic rocks, are exposed in several places on the reservation (Figure 2). They

include fanglomerates and mudflows with interbedded tuffs adjacent to the mountains and gravelly, sandy, and silty material containing small amounts of marl and rhyolite tuffs in the basins. Except near source areas, the gravels are composed of a heterogeneous mix of Precambrian rock fragments. Some rocks are well cemented (usually with calcite); others are barely consolidated. Near Prescott these Tertiary rocks lie directly over the Precambrian basement.

Quaternary.--Once extensive pediment gravels that now crop out in a small area south of the reservation are composed of a heterogeneous mix of boulders, cobbles, and finer material derived from rocks of all ages. Recent alluvium occurs in basins and along gulches.

STRUCTURE

Deformation during the Precambrian, although intense, did not affect the granites near the Yavapai Reservation. Normal faulting, development of sharp monoclines, and gentle folding since the end of the Paleozoic have affected strata near the reservation.

MINERAL RESOURCES

General

Mining has been practiced in the Prescott region since prehistoric times as evidenced by stone implements recovered from ancient mine workings (Anderson and Creasey, 1958; Galbraith and Brennan, 1970). Recorded mining activity in the region commenced in 1863 with the discovery of placer gold on Hassayampa River and Lynx Creek (Eilers, 1872). Lode mining began shortly thereafter for gold and silver in the oxidized portions of numerous vein deposits that occur throughout the region. As metallurgical techniques improved, attention was turned to sulfide ores, and three deposits--United Verde, United Verde Extension, and Iron King--became major producers until the last of the three, the Iron King, closed down in 1968 (records of the Arizona Department of Natural Resources).

Mineral commodities that have been produced in the region include barite, copper, gold, lead, mercury, sand and gravel, silver, tungsten, and zinc. Occurrences of fluorite and olivine have been reported in the region (Kreiger, 1965), but no discoveries have been made that warrant further consideration.

Upon the discovery of gold in the Prescott region, Federal troops were dispatched to protect the miners, and Fort Whipple was established in 1863. In 1935, Congress set aside 75 acres of Fort Whipple as the Yavapai Indian Reservation, and in 1965 additional acreage was added to the reservation (U.S. Department of Commerce, 1974). About 250 acres of Fort Whipple is still held by the U.S. Veterans Administration for a Veterans Hospital, and about 50 acres is used as a City Park.

Because the entire Yavapai Indian Reservation has been held as a Military Reservation virtually since prospecting in the region first began, it is likely that it has not been explored thoroughly. Sand and gravel and some gold have recently been produced on the reservation from alluvial deposits along Granite Creek. Kreiger (1965) has noted the

presence of quartz veins, dikes, and two major fault zones on the reservation. In other parts of the region, similar structures have been associated with mineralization.

Metallic Mineral Deposits

Gold Placers

In 1862 and 1863, a party of prospectors led by Joseph R. Walker found placer gold in the Hassayampa River, Groom Creek, Bib Bug Creek, Lynx Creek, and Granite Creek (Wilson and Fansett, 1961). These streams drain the areas west, south, and east of Prescott. Gold deposition resulted from the erosion of numerous quartz veins (Kreiger, 1965) that occur in the region. Placer mining commenced in 1863 and continued until the World War II period. Estimates of early production and incomplete recorded production figures suggest that approximately $6,000,000 worth of gold may have been taken out of the placers.

Granite Creek, a known gold-bearing stream, flows through the reservation and was mined for gold both above and below the reservation. Whether or not gold was mined from that portion of the stream within the reservation or from its tributaries within the reservation is not known.

A sand and gravel lease in force since August 1965, and under consideration for renewal in 1979 cites placer gold and silver as commodities that could be recovered. A small amount of gold is said to have been produced, but records indicate that none is being produced now. (Production records of the BIA, Phoenix, Arizona 1979).

Gold and Silver Veins

The Prescott region contains numerous fissure veins that attracted early attention because of gold and silver values. Descriptions of the mining operations by Eilers (1872), Blandy (1883), Lindgren (1926), and Wilson and others (1934) effectively portray the part these veins played in the early days of the region. On the surface, some of the veins were very high in grade and continued to be so down to where the "sulphurets" were not amenable to the ore dressing methods in practice at that time (Blandy, 1883). As a consequence, the operations were abandoned.

Lindgren (1926) considered that there were two basic types of veins in the region: 1. Precambrian veins, containing massive quartz, minor amounts of ankerite, siderite, and tourmaline and carrying free gold, pyrite, chalcopyrite, sphalerite, and galena in small amounts; he estimated that less than $1,000,000 worth of gold came from these veins. 2. Veins that Lindgren thought to be much younger, possibly late Mesozoic or early Tertiary in age. They contain milky, drusy quartz, usually with ankerite and some with barite, fluorite, albite, and adularia. Sulfides in small amounts include arsenopyrite, pyrite, sphalerite, chalcopyrite, galena, tetrahedrite, and proustite or pyrargyrite. The valuable commodity was gold or silver or a mixture of both. Gold is associated with the arsenopyrite and pyrite, the silver with the tetrahedrite and galena. Tungsten minerals have also been found in these younger veins, which have been more productive than the older veins; Lindgren (1926) estimated that values in the range of

$18,000,000 had been produced from the younger veins.

Massive Sulfide Deposits

Massive sulfides deposits with little or no gangue minerals have been by far the most productive type of ore body found in this part of Arizona. The United Verde and United Verde Extension mines, located about 23 miles northeast of the reservation, produced about 1,890,000 ounces of gold, 65,600,000 ounces of silver, 1,868,000 tons of copper 37,725 tons of lead, and 127,000 tons of zinc between 1883 and 1953 (Anderson and Creasey, 1958). The Iron King mine, located about 8 miles southeast of the reservation, was operated sporadically from 1906 to 1937 and then continuously until 1968. During that time, it produced 693,454 ounces of gold, 20,626,053 ounces of silver, 143,717 tons of lead, 419,185 tons of zinc, and 11,328 tons of copper. At present, (1980) old mill tailings are being processed for use as a soil conditioner (Record of the Arizona Department of Mineral Resources).

The primary minerals found in the massive sulfide deposits have been predominantly pyrite with lesser amounts of chalcopyrite, sphalerite, and galena. Host rocks commonly are silicified and sericitized, and the deposits are believed to have been formed by replacement (Lindgren, 1926).

Tungsten Deposits

At least 20 veins or groups of veins containing tungsten minerals, either scheelite or wolframite or both, occur within a radius of about 25 miles of Prescott to the southwest, south, and southeast (Dale, 1961). A number of these veins have been worked for gold and silver and some were worked only for tungsten (Lindgren, 1926, Wilson, 1941, and Dale, 1961). The veins generally contain quartz, tourmaline, and epidote, often with pyrite, arsenopyrite, sphalerite, chalcopyrite, bornite, and other sulfide minerals. The tungsten minerals are scattered and range in size from microscopic particles up to pieces 2 inches in diameter. The host rocks are granite, pegmatitic material, and schist.

Early production was obtained from float and the reworking of old dumps about the time of World War I, but the greatest interest in tungsten appears to have been during the 1950's. None of the deposits were large producers with much of the production being measured by the tens or hundreds of pounds of handpicked ore or concentrate.

It is calculated, from production estimates made by Dale (1961), that total production of tungsten concentrate from the Prescott region was only 37 tons during the 1916-1956 period.

Mercury (Quicksilver) Deposits

About 10 miles southwest of Prescott in an area known as "Copper Basin," a number of workings were created in exploration for mercury, The mercury occurs as cinnabar, a sulfide mineral, in veins of chalcedonic quartz that are enclosed in granite and grabbro, usually accompanying dikes of andesite or rhyolite porphyry (Lausen and Gardner, 1927).

In 1904, two or three flasks of mercury were produced for local use in amalgamation. In 1924,

four groups of claims were staked, and some exploration work was done. A small amount of ore was produced, but no report of metal production was found.

Nonmetallic Mineral Deposits

Sand and Gravel

Sand and gravel is found in bars and embankments along the stream bed of Granite Creek. Reserves have not been determined, and any prior estimates would be suspect because it appears that the deposits have been rearranged and shifted from time to time by flood waters.

At least four private operators and the Arizona State Highway Department have mined sand and gravel on reservation land since 1959 (Records of the BIA, Phoenix office). One of the leases held by Charles O. Prose provides for the mining of placer gold and silver as well as sand and gravel.

Production records of the BIA show:

Year	Leases	Production (yds^3)	Tribal Income
1974	2	98,077*	$34,534.79
1975	2	71,497*	$25,860.81
1976	1	23,506	$ 6,770.25
1977	2	50,187	$15,473.20

*Converted from tons by the factor 1.5 tones = 1 cubic yard.

Some gold was produced before these records were started.

Decomposed Granite

South of State Highway 69, 1.5 to 2 miles east of Prescott, decomposed granite has been mined from two pits in Government Gulch (Kreiger, 1965). This material is similar to that found in many other deposits in the Prescott area. It is used as fill in road construction and other construction work. Because the feldspar has been altered to clay, the material is not well-suited to construction (BIA, Phoenix office files). For road construction, it must be covered with crushed rock and blacktop or concrete to be acceptable. The decomposed granite was mined by two lessees between 1966 and 1975 at royalty payments ranging from 15 cents per cubic yard in 1966 to 23 cents per cubic yard in 1`975. Neither deposit was considered to have large reserves, and they may now be worked out. Tonnages mined on the reservation were not

available, but they have been estimated at approximately 500,000 yards. Recent BIA production reports show no figures for decomposed granite. If the demand warrants, similar deposits might be found elsewhere on the reservation.

Barite

Barite occurs as a gangue mineral in some of the silver- bearing quartz veins in the Prescott region (Blandy 1883; Jaggar and Palache, 1905; and Lindgren, 1926). One mine, in sec. 2, T. 12 N., R. 3 W., about 10 miles southwest of Prescott, has been worked for barite. The mine was located in 1880 and produced several hundred tons of silver ore (Stewart and Pfister, 1960). When the mine was examined in 1958, it had been closed for many years. Handpicked ore from the dump was sampled, giving results:

Barite	40.4%
Lead	2.2%
Zinc	1.4%
Silver	26 ounces/ton
Gold	trace

The vein is in a fault zone in diorite and is largely quartz with occasional stringers and small pods of barite. The amount of barite produced is not known but it was probably minor.

Olivine (Peridot)

Kreiger (1965) reports phenocrysts of olivine in basalt, up to 1.5 inches in diameter in one locality. At least two basalt outcrops are on the Yavapai Reservation, but whether they contain phenocrysts of olivine has not been recorded. Olivine crystals of good size and quality are cut and polished and used as a gemstone under the name "peridot." Several places in Arizona produce gem quality olivine from basalt beds, from basalt detritus, and from other volcanic rocks. Arizona is an outstanding producer of this gem stone (Sinkankas, 1959)

Building Stone

Granodiorite and tuffaceous sedimentary rocks quarried near Prescott have been used as building stone in the city (Kreiger 1965). Both of these rock types are found on the Yavapai Reservation. If a local market demand sufficient to support a building stone industry should evolve, suitable deposits might be found on the reservation.

RECOMMENDATION FOR FUTURE WORK

A field examination should be made of the reservation to include:

1. An examination and sampling of quartz veins
2. A reconnaissance to determine the possible existence of mineralized areas and mineral-related alteration zones.

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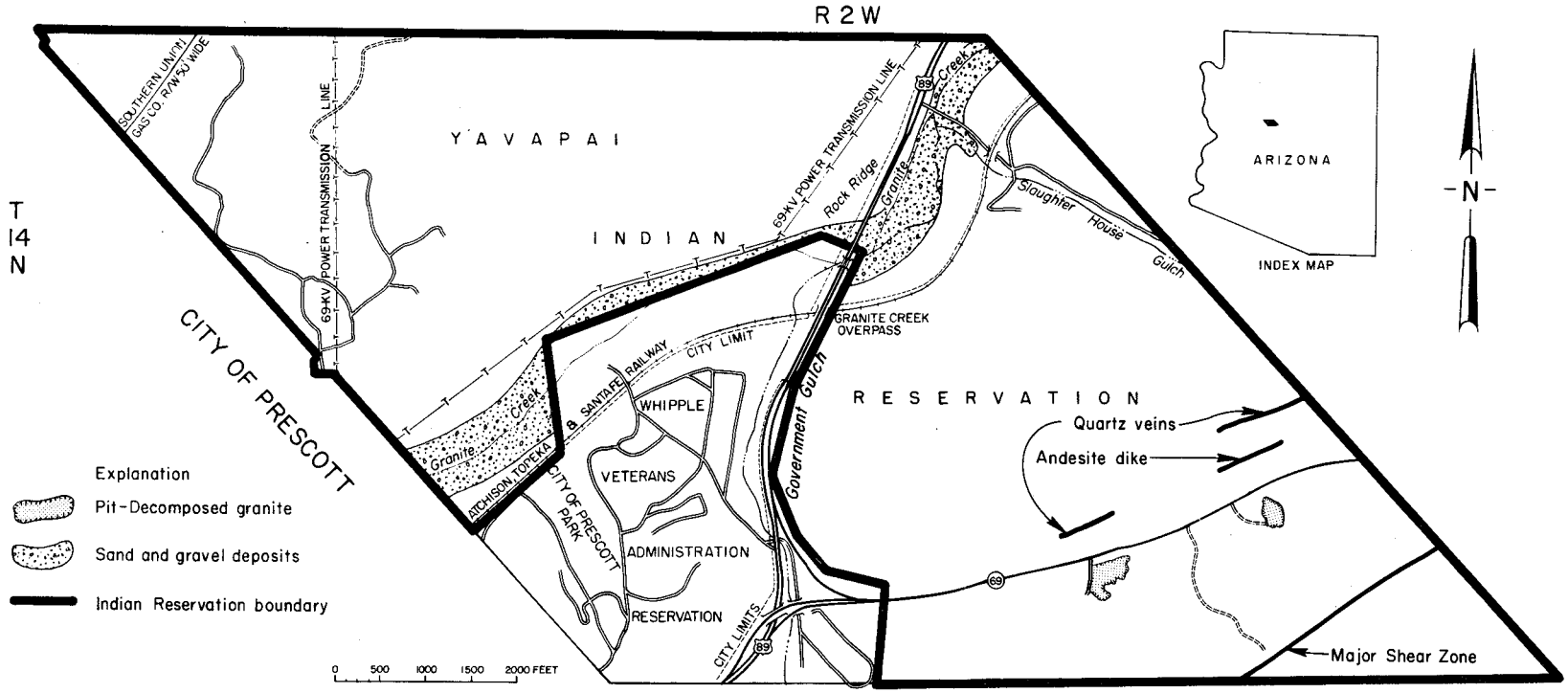

Figure 1. Index map of the Yavapai Indian Reservation, Yavapai County, Arizona

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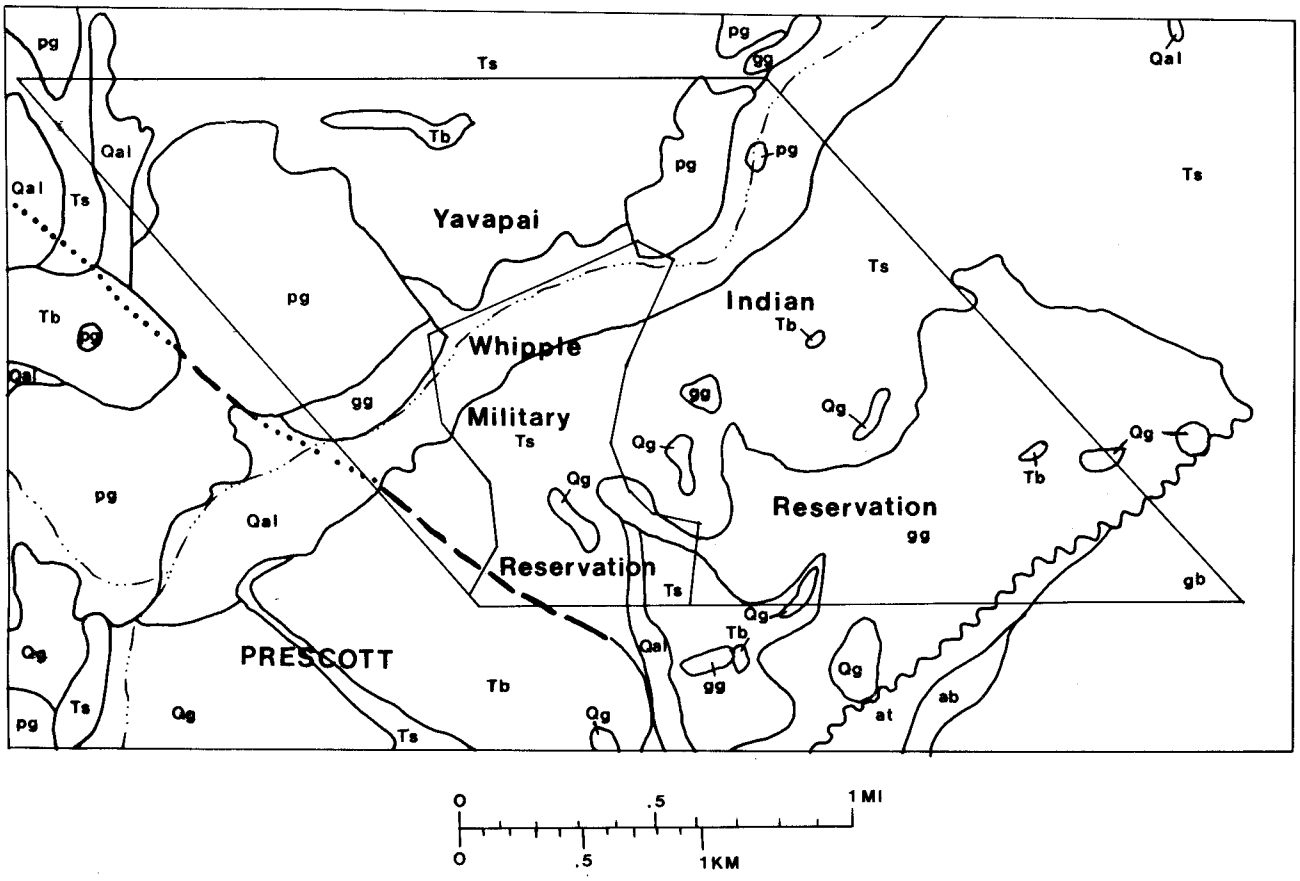

QUATERNARY

Qal	gravel and alluvium
Qg	pediment and terrace gravels

TERTIARY

Tb | Ts	Tb - basaltic flows
	Ts - fanglomerate, gravel, and fine grained fluviatile and lacustrine deposits, some interbedded tuffaceous rocks

PRECAMBRIAN

pg	Prescott granodiorite
gg	Government Canyon granodiorite
gb	gabbro
ab | at	ab - unnamed basalt of Alder Group
	at - unnamed tuffaceous rocks of Alder Group

Figure 2. Geologic map of the Yavapai Indian Reservation, Arizona, from Krieger, 1965